

8687

VOLT POTENTIOMETER

LEEDS



NORTHROP

PHILADELPHIA 44, PA.

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8687

VOLT POTENTIOMETER

1. GENERAL INFORMATION

The 8687 Volt Potentiometer is for precision d-c measurements in laboratory and plant and can be used as a source of calibrated d-c voltages (emf output).

It includes a built-in lamp-and-scale galvanometer, standard cell, and batteries and has provision for recalibrating the internal standard cell voltage.

This instrument is supplied in a metal case with a slip-hinged lid, snap latch, and handle as shown in

Fig. 1. A view of the operating panel, with the lid removed, is shown in Fig. 2.

The basic instrument consists of two selector switches A and B, and a slidewire C, plus a switch to select the function to be performed. The two selector switches and the slidewire are so arranged that the value of voltage, corresponding to their positions, appears at a central readout window as a single row of digits, including a scale reading.

The major specifications are as follows:

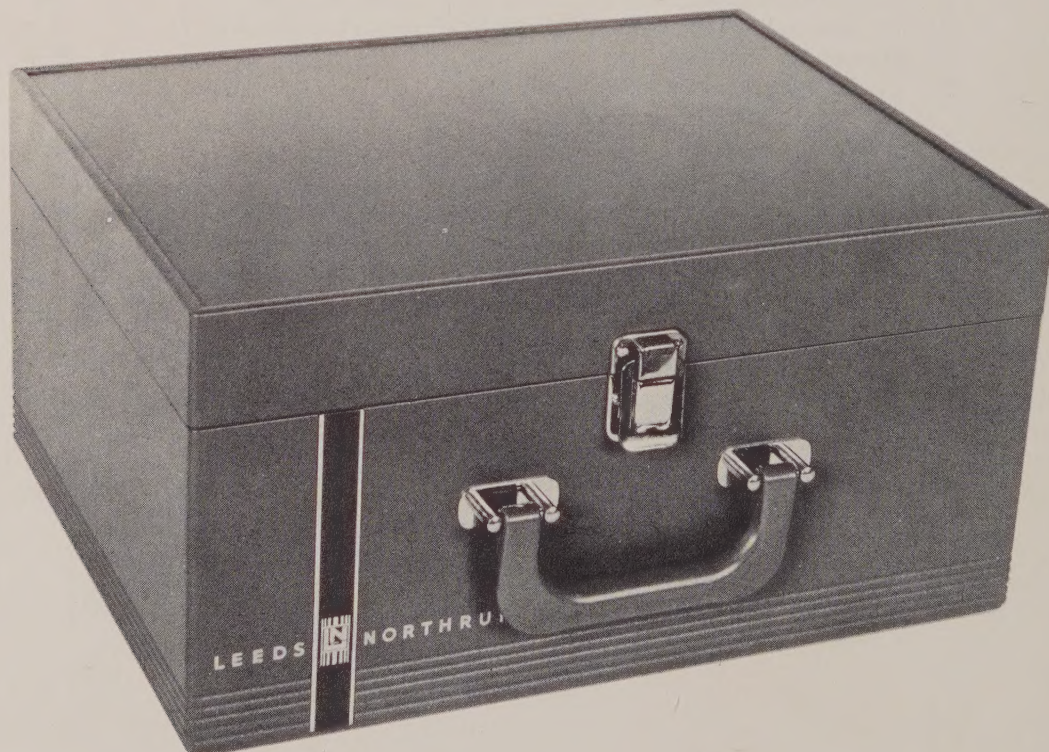


Fig. 1—8687 Potentiometer, exterior.

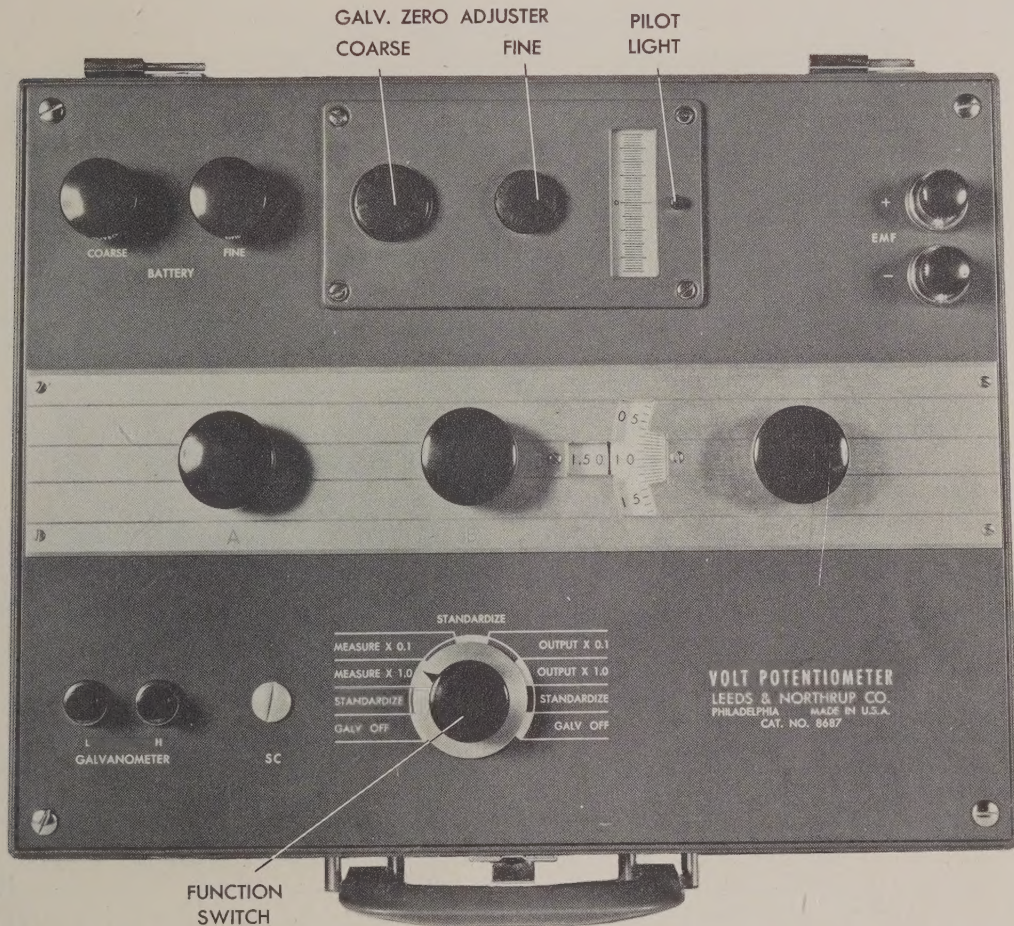


Fig. 2—8687 Potentiometer, top view with lid removed.

	<u>X1.0 Range</u>	<u>X0.1 Range</u>
RANGE.....	0 to 1.601 volts	0 to 0.1601 volt
LIMITS OF ERROR.....	$\pm(0.05\% + 30 \mu v)$	$\pm(0.05\% + 3 \mu v)$
SWITCH A SCALE	15 x 0.1 volt	15 x 0.01 volt
SWITCH B SCALE	9 x 0.01 volt	9 x 0.001 volt
SLIDEWIRE C SCALE.....	0 to 0.011 volt. Smallest division 50 μv . Adjustable to $\pm 10 \mu v$.	0 to 0.0011 volt. Smallest division 5 μv . Adjustable to $\pm 1 \mu v$.
STD. CELL ADJ. RANGE	1.0170 to 1.0200 volts	

TABLE I—FUNCTION SWITCH, DESCRIPTION OF POSITIONS

SWITCH POSITION	FUNCTION
GALV OFF	Galv. disconnected and shorted. Lamp off. No measurement can be made
STANDARDIZE	Standardize potentiometer circuit current
MEASURE X0.1	Measure voltage in range X0.1
MEASURE X1.0	Measure voltage in range X1.0
OUTPUT X0.1	Source of voltage in range X0.1. Galv. disconnected and shorted. Lamp off
OUTPUT X1.0	Source of voltage in range X1.0. Galv. disconnected and shorted. Lamp off

2. DESCRIPTION OF MAJOR COMPONENTS

A. Function Switch

This switch provides the means of selecting the operation (function) for which the instrument is to be used. Positions are provided for emf measurements and for using the instrument as a source of calibrated emf for checking other instruments. Other positions include three for adjusting the current in the potentiometer circuit, and two for disconnecting the galvanometer from the circuit and shorting it for protection during transportation.

Table I lists these switch positions, summarizes the functions, and notes other effects.

B. BATTERY Rheostats

These rheostats, marked COARSE and FINE, are used to adjust (standardize) the battery current in the potentiometer circuit.

C. GALVANOMETER Keys

These keys, marked L (low) and H (high), determine the sensitivity of the galvanometer.

D. SC Voltage Divider

This voltage divider is located under the screw cap at SC on the operating panel and is used to adjust for long term changes in the voltage of the standard cell.

E. Potentiometer Balancing Switches and Slidewire

Switches A and B and slidewire C are used to obtain a circuit balance when measuring an unknown voltage or to set the value of calibrated voltage when using the instrument as a voltage source.

The scale markings for the positions of switches A and B and slidewire C are read directly as a row of digits. Slidewire C is provided with a range of 0.01 volt plus an overlap of 0.001 volt at the high end, on the X1.0 range. This overlap is indicated when the black background of the slidewire scale appears at the window. Under this condition, 0.01 volt must be added to the reading as it appears at the window. In the case of the X0.1 range, the final reading must be multiplied by 0.1.

Table II gives some pertinent data on these switches and the slidewire.

TABLE II—SWITCHES A AND B AND SLIDEWIRE C, RANGES

SWITCH A			SWITCH B			SLIDEWIRE C				
POSITIONS	RANGE (Volts)		POSITIONS	RANGE (Volts)		POSITIONS	RANGE (Volts)		TOTAL RANGE (Volts)	
	X1.0	X0.1		X1.0	X0.1		X1.0	X0.1	X1.0	X0.1
0 to 1.5	0 to 1.5	0 to 0.15	0 to 9	0 to 0.09	0 to 0.009	1000 (approx)	0 to 0.011	0 to 0.0011	0 to 1.601	0 to 0.1601

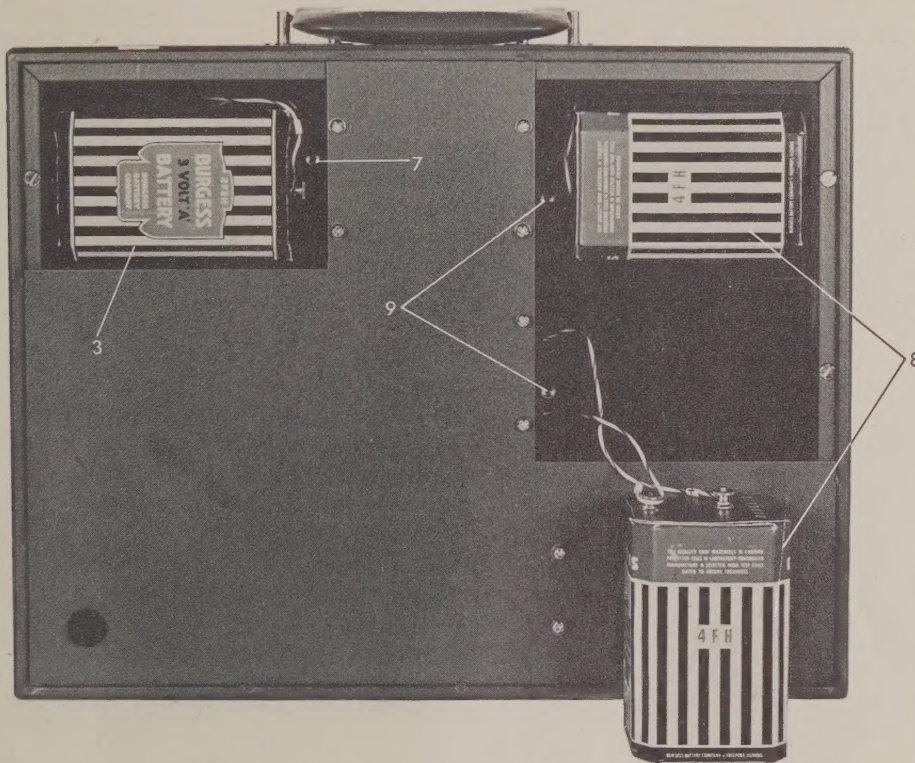


Fig. 3—8687 Potentiometer, bottom view with covers removed to show batteries.

F. Galvanometer Assembly

The galvanometer assembly is a complete light beam type unit with the following nominal characteristics:

Sensitivity	$\pm 0.025 \mu\text{a/mm}$ ($\pm 26 \mu\text{v/mm}$)
Coil Resistance	60 ohms
CDRX	1000 ohms
Period	3 seconds

For further details on this assembly, refer to Directions 177129.

G. Standard Cell

The standard cell provides the

reference voltage to which the battery is adjusted to provide the standard current in the potentiometer circuit. It is an unsaturated cell and should be used only where the ambient temperature remains between 0 C and 50 C (32 F and 122 F).

The useful life of the cell, with periodic calibration, should be approximately five to seven years.

H. Batteries

The three batteries, required for operating the instrument, are mounted in three plastic compartments in the bottom of the instrument case (see Fig. 3) and are accessible by removing the covers from the bottom of the case.

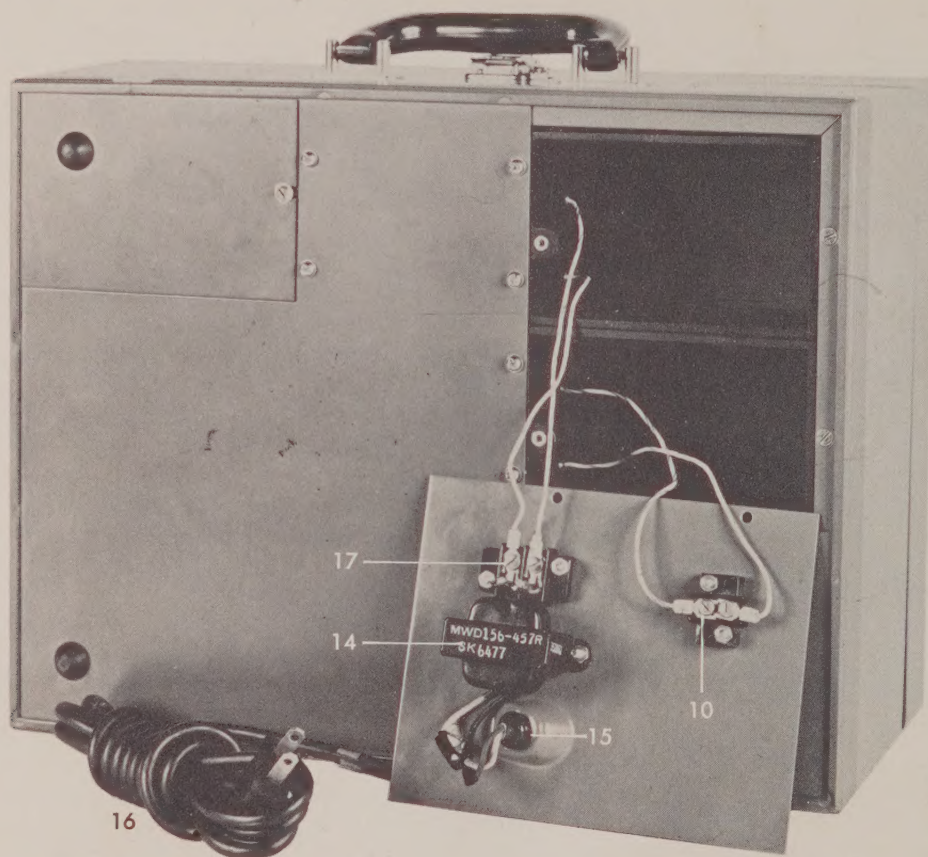


Fig. 4—8687 Potentiometer, bottom view showing transformer supply for galvanometer lamp.

The 3 volt battery at 3, Fig. 3, furnishes current to the potentiometer circuit. The two 1.5 volt batteries are connected in series for the 3 volt power source for the galvanometer lamp.

J. A-C Supply for Galvanometer Lamp

This supply consists of a 120/3 volt, 50-60 cycle transformer and is supplied in place of the two 1.5 volt batteries for the galvanometer lamp only when specifically ordered.

The components for this arrangement are shown in Fig. 4 and occupy

the space in the instrument case left vacant by the two batteries. The transformer is shown at 14, Fig. 4. The bushing 15 is for the incoming power leads 16.

3. PRINCIPLE OF OPERATION

This instrument is basically a double-branch potentiometer. The complete wiring diagram is shown in Fig. 7.

On the X1.0 range, one branch consists of fifteen steps of 0.1 volt each (switch A), plus nine steps of 0.01 volt each (switch B), coupled in a Kelvin-Varley arrangement. The

other branch consists of the 0 to 0.011 volt slidewire.

On the X0.1 range, this differs only in that series resistor R6 and parallel resistor R5 are connected in the potentiometer circuit in order to obtain the lower range.

The circuit is designed for a total battery drain of 3 ma. On the X1.0 range, 1 ma is in the slidewire branch and 2 ma in the other branch. When on the X0.1 range, the current in each branch is 0.1 of the values for X1.0 range.

The voltage drop between the contact on the SC voltage divider and a fixed point beyond resistor R7 (see Fig. 7), is applied in opposition to the standard cell voltage for standardization of the current in the potentiometer circuit. If the value of this current is correct, the voltage drop will balance the standard cell voltage and no adjustment is necessary. However, if the current is not correct, the unbalance which occurs is corrected by adjusting BATTERY rheostats COARSE and FINE for a balance.

4. OPERATION

A. Voltage Connections

If a voltage source is to be measured, connect it to the EMF binding posts.

If the potentiometer is to be used as a source of calibrated voltage, connect the device to be supplied by this voltage to the EMF binding posts.

B. To Check Mechanical Zero of Galvanometer

See that the GALVANOMETER keys L and H are open (in the up position).

Turn the function switch to one of the STANDARDIZE positions and observe the balance point of the galvanometer. If it does not balance at zero, make the adjustment as outlined in Directions 177129.

C. To Standardize Potentiometer Circuit Current

Turn the function switch to one of the STANDARDIZE positions.

Depress the GALVANOMETER L key and note the galvanometer for any deflection. If it does not balance at zero, adjust the BATTERY COARSE rheostat until there is very little or no deflection of the galvanometer when the GALVANOMETER L key is depressed or released.

Then depress the GALVANOMETER H key and adjust the BATTERY FINE rheostat until the galvanometer remains at zero when the H key is depressed or released.

D. Measure Voltage

(1) Preliminary Adjustments

Be sure that all preliminary checks and adjustments have been made.

(2) To Make a Reading

- Turn the function switch to either the MEASURE X1.0 or MEASURE X0.1 position, depending upon the range desired.

- Turn switches A and B to 0 on their respective scales.

- Turn slidewire C to the black 00 (on a white background).

- Depress GALVANOMETER key L momentarily and note the

direction of deflection of the galvanometer.

- Rotate switch A clockwise, one major division at a time, depressing key L momentarily after each move, until the direction of deflection of the galvanometer reverses. Then rotate switch A back one major division.

- Rotate switch B clockwise, one major division at a time, depressing key L momentarily after each move, until the direction of deflection of the galvanometer reverses. Then rotate switch B back one major division.

- Rotate slidewire C clockwise, using key L to check for a galvanometer deflection, until the galvanometer balances at zero or until a very small deflection is noted.

- Use GALVANOMETER key H and slidewire C to obtain the final balance of the galvanometer.

The value at the index of the readout window is the value of volts being measured. For details on reading this value, refer to Section 2E.

The following examples illustrate the method of reading.

READINGS					
A	B	C	Background Color of C Scale	Range	Total Volts
1.5	9	10	white	X1.0	$1.5910 \times 1.0 = 1.5910$
1.5	9	10	white	X0.1	$1.5910 \times 0.1 = 0.1591$
1.5	9	00	$\frac{1}{2}$ white $\frac{1}{2}$ black	X1.0	$1.5900 + 0.01 = 1.6000$
1.5	9	10	black	X1.0	$1.5910 + 0.01 = 1.6010$
1.5	9	10	black	X0.1	$(1.5910 + 0.01) \times 0.1 = 0.16010$

E. To Supply Calibrated Voltage

(1) Preliminary Adjustments

CAUTION: This instrument can be used as a voltage source but it is not designed to supply current. Ac-

curacy of the output voltage is decreased if current is drawn from the potentiometer. Therefore, it should be used only in null circuits where the voltage of the external circuit is equal and opposite to the voltage provided by the instrument.

Be sure that all preliminary checks and adjustments have been made.

(2) To Obtain Voltage

- Turn the function switch to either the OUTPUT X1.0 or the OUTPUT X0.1 position, depending upon the range desired.

- Rotate switches A and B and slidewire C until the desired value of output voltage appears opposite the index of the readout window.

Either the L or H GALVANOMETER key may be closed to complete the circuit. However, when the L key is used, a 10,000 ohm resistor is in series in the positive (+) side of the circuit.

5. MAINTENANCE

A. To Remove Instrument Panel

Turn each mounting screw (one in each corner of the panel) two complete turns counterclockwise to release the clamping nut from the ledge inside the case. The mounting screws remain in place in the panel. Lift the panel from the case.

B. To Replace Instrument Panel

Turn the clamping nut, on each mounting screw, so that it will clear the ledge inside the case when the panel is fitted into place on the case. After the panel is positioned on the case, turn each mounting screw

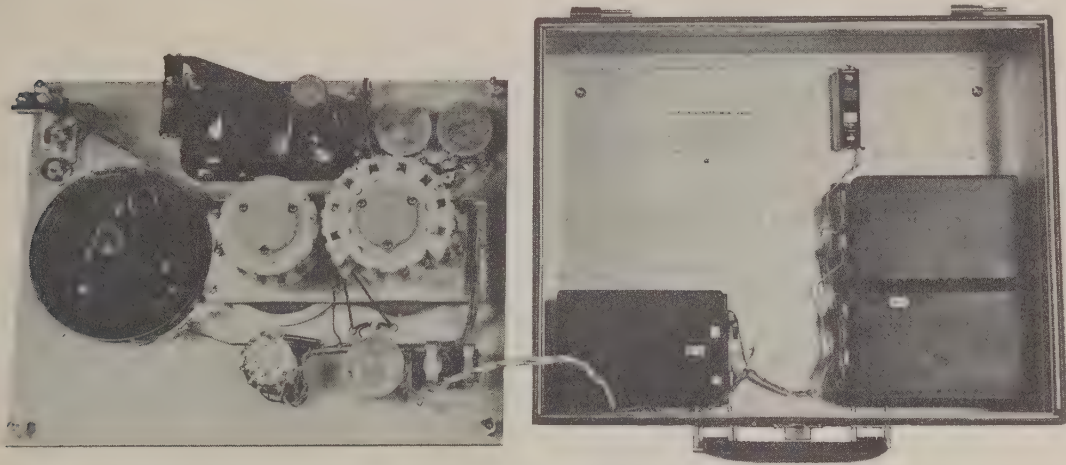


Fig. 5—8687 Potentiometer, view showing under side of instrument panel and inside of case.

counterclockwise until a click is heard and then turn each screw clockwise until it is tight.

C. To Replace Batteries

CAUTION: If instrument is to be stored for an extended period, remove all batteries and store separately to prevent damage from possible leaking batteries.

(1) For Potentiometer Circuit

When BATTERY rheostats COARSE and FINE reach the limit of their adjustments because of a depleted battery, the 3 volt battery in compartment 3, Fig. 3, should be replaced.

To replace this battery, remove the screw at 7, Fig. 3, and lift the cover off the compartment.

(2) For Galvanometer Lamp

When batteries are used for this purpose and insufficient light is obtained on the galvanometer scale, the two 1.5 volt batteries at 8, Fig. 3, should be replaced.

To replace these batteries, remove the two screws at 9, Fig. 3, and lift the cover off the compartments.

D. To Remove Galvanometer Assembly

To remove the complete galvanometer assembly, remove the four screws, one in each corner of the galvanometer panel, and lift the galvanometer panel, with the galvanometer assembly attached, from the instrument case.

To remove the galvanometer system from the assembly, refer to Directions 177129 for the galvanometer.

When replacing the galvanometer assembly, be sure the coarse zero adjuster is at the left side as shown in Fig. 2.

E. To Replace Galvanometer Lamp

To replace this lamp, it is necessary to remove the galvanometer assembly from the instrument and then follow the appropriate Section in Directions 177129 for the galvanometer.

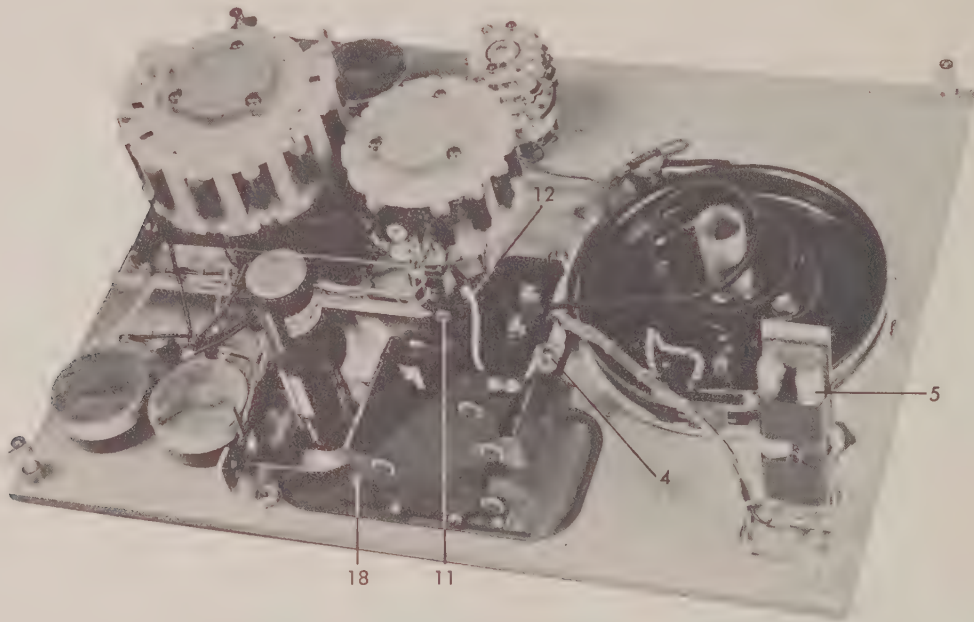


Fig. 6—8687 Potentiometer, detailed view of under side of instrument panel.

F. Standard Cell

(1) To Replace

This cell should give satisfactory service for several years. However, if it is ever necessary to replace it, remove the instrument panel from the case.

Note the connections to the standard cell 5, Fig. 6. Then disconnect and remove it from the panel.

(2) To Adjust for Standard Cell Voltage

The limit of error (accuracy) of the instrument includes the accuracy of the standard cell. Thus, a change in the voltage of this cell will affect the accuracy of the readings. Therefore, it is recommended that the voltage of the standard cell be checked approximately twice a year, using the

following procedure:

- Connect a calibrated d-c voltage of approximately 1 volt (standard cell or precision potentiometer) which is known to within $\pm 0.01\%$, to the EMF terminals of the instrument.

- Set switches A and B and slidewire C to obtain the value of the calibrating voltage, connected in the preceding step, at the index of the readout window.

- Turn the function switch to the MEASURE X1.0 position.

- Adjust the BATTERY rheostats COARSE and FINE, depressing first the GALVANOMETER key L and then key H to obtain a galvanometer balance.

- Turn the function switch to one of the STANDARDIZE positions.

- Remove the cap screw at SC, Fig. 2, to expose the screwdriver adjustment of the standard cell voltage divider. Depress the GALVANOMETER key L and adjust the standard cell voltage divider for galvanometer balance or close to balance.

- Then depress GALVANOMETER key H and adjust the standard cell voltage divider for galvanometer balance.

- Replace the cap screw at SC.

G. Cleaning

(1) Measuring Circuit Slidewire C

This slidewire may require occasional cleaning over extended periods of time, depending upon the conditions under which the instrument is used. Remove the instrument panel from the case. Rub a clean cloth, moistened with Cramolin*, over the contact surface of the slidewire. Allow the Cramolin to remain for at least 30 seconds and then take a clean section of the cloth and remove the excess Cramolin. Do not apply any lubricant to the slidewire and never use any abrasive material on the slidewire as this would destroy the uniformity of the slidewire.

(2) Galvanometer Assembly

For details on cleaning the galvanometer assembly, refer to Directions 177129.

(3) General

The finish on this instrument is a paint which has greater resistance to chipping and scratching than a baked enamel finish. If necessary, the instrument case may be cleaned with a soft cloth dampened with water containing a small amount of a mild

detergent. Do not use water on the under surface of the galvanometer scale. See Directions 177129 for details on cleaning this item.

The readout window and instrument panel may be cleaned in the same manner.

The EMF terminal insulators are a plastic which is affected by some chemical solvents. Therefore, chemical solvents should not be used.

6. REPLACEMENT PARTS

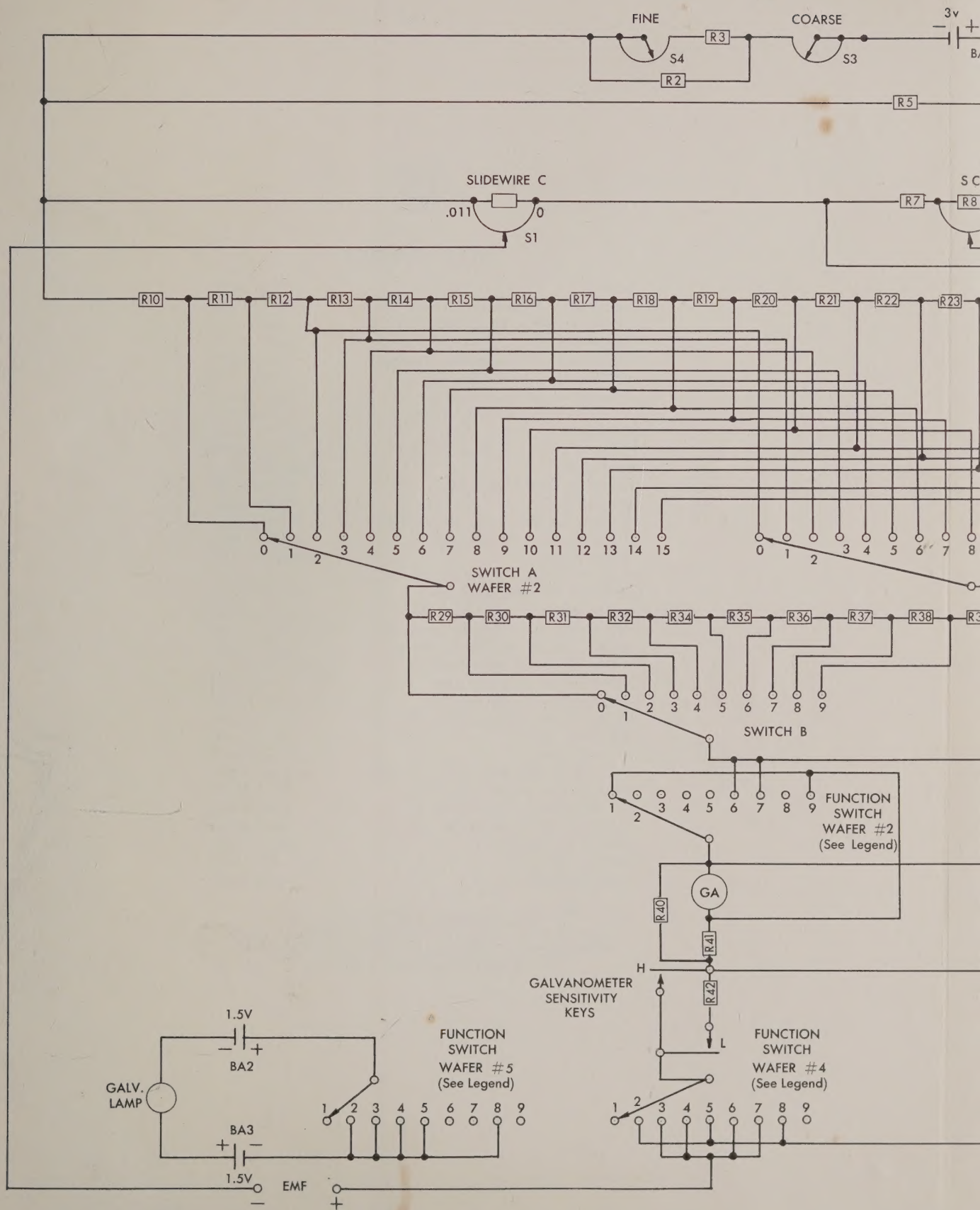
Description	L&N® Part No.
Battery, 1.5 volt (Burgess, 4FH, Little Six)	Std. 2233-1
Battery, 3 volt (Burgess, 2F2H, A)	56-1-0-4
Standard Cell	130007
*Galvanometer, system only	062103
Binding Post Head	002199
Screw Assembly, panel mounting	- - -
Screw	4-4-1-24
Spring, upper	28-1-3-10
Spring, lower	28-1-3-9
Clamp Nut	72-4-1-1
Retaining Ring	27-3-3-12
Plastic readout window	066121
Key, GALVANOMETER H, lock down	PI-123-L
Key, GALVANOMETER L, non-lock down	PI-123-N
Screw, plug, SC voltage divider	Std. 3091-AB
Screw, mounting, galvanometer assembly	1/4 - 6-32 pan head brass - CR.P.

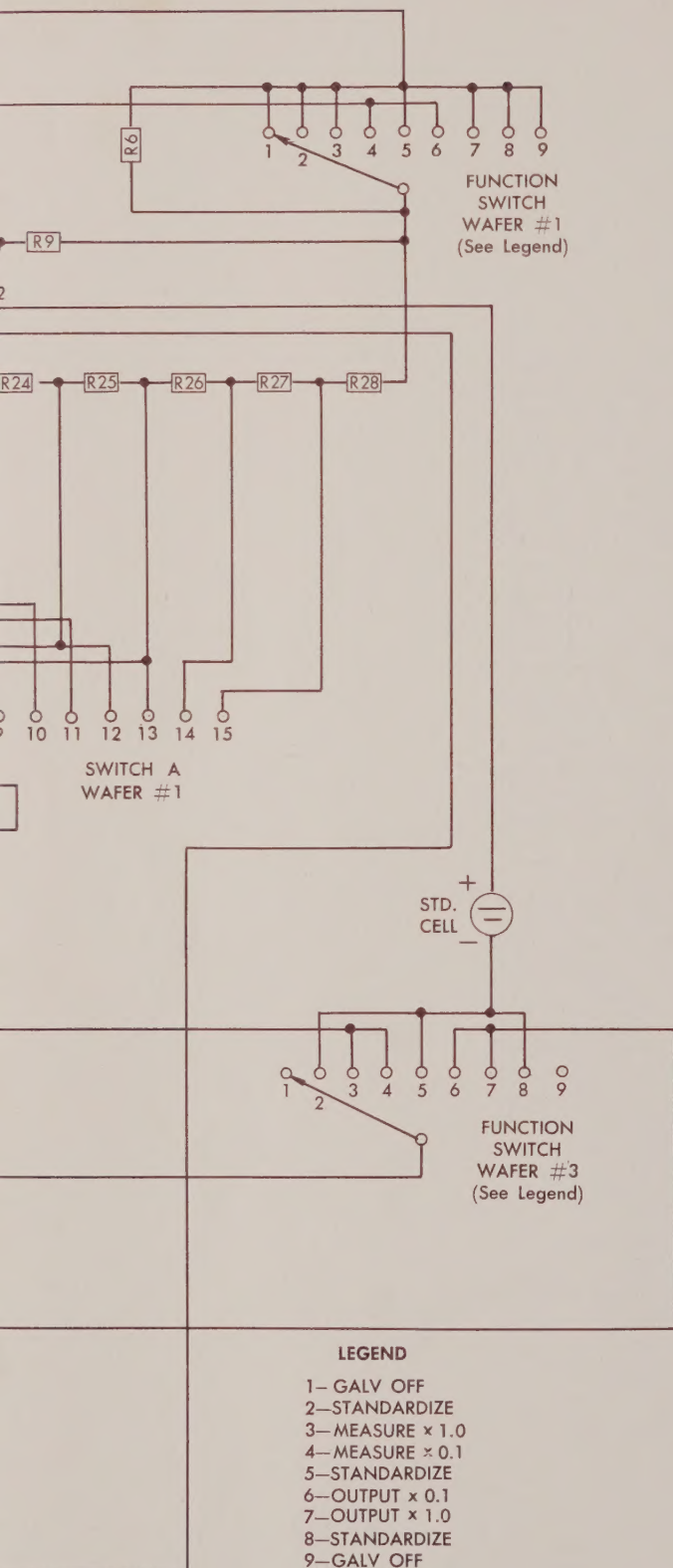
* For further data on replacement parts for the galvanometer assembly, refer to Directions 177129.

7. AUXILIARY EQUIPMENT

Description	L&N Part No.
Line operated 3 volt power supply (transformer) for galvanometer lamp	099007

* Caig Laboratories, Long Island, N.Y.





RESISTORS

Symbol	Value	Symbol	Value
R2	5.0 Ω	R23	50.0 Ω
R3	4.0 Ω	R24	
R5	66.667 Ω	R25	
R6	540.0 Ω	R26	
R7	1017.0 Ω	R27	50.0 Ω
R8	3.046 Ω	R28	94.25 Ω
R9	768.5 Ω	R29	10.0 Ω
R10	5.75 Ω	R30	
R11	50.0 Ω	R31	
R12		R32	
R13		R33	
R14		R34	
R15		R35	
R16		R36	
R17		R37	
R18		R38	
R19		R39	10.0 Ω
R20		R40	390.0 Ω
R21		R41	680.0 Ω
R22	50.0 Ω	R42	10.0K

MISCELLANEOUS

Symbol	Value	Description
S1	*120 Ω	Slidewire C
S2	▲200 Ω	SC calibration voltage divider
S3	560.0 Ω	COARSE rheostat
S4	10.0 Ω	FINE rheostat

*shunted to 11.5 ▲shunted to 3.046





FIELD OFFICES

ALBANY	Union	9-9079
ATLANTA 5, 3084 Grandview Ave., N. E.	Cedar	7-8624
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BATON ROUGE	Dickens	3-4065
BOSTON 66, 430 Lexington St., Auburndale	Lasell	7-9360
BUFFALO 15, 3685 Harlem Road	Atwater	8900
CHICAGO 1, 307 N. Michigan Ave.	Central	6-3428
CINCINNATI 36, 8005 Plainfield Rd.	Sycamore	1-2274
CLEVELAND 6, 1922 E. 107th St.	Sweetbriar	1-5100
COLUMBUS 12, 1465 Northwest Blvd.	Hudson	6-7146
DAVENPORT	Davenport	6-3100
DENVER 2, 1545 Glenarm Place	Acoma	2-1808
DES MOINES	Cherry	3-6081
DETROIT 35, 18240 James Couzens Highway	Diamond	1-2320
E. ORANGE, N. J., 99 Washington St.	Orange	2-3420
GRAND RAPIDS	Glendale	4-2161
HARTFORD 7 (West), 10 N. Main St.	Adams	2-4474
HOUSTON 27, 3939 Essex Lane	Mohawk	7-7481
INDIANAPOLIS 18, 3513 N. Hovey St.	Walnut	6-2462
KANSAS CITY 14, 7935-A1 State Line Rd.	Jackson	3-8199
LOS ANGELES 22, 5111 Via Corona Ave.	Angelus	9-3191
MILWAUKEE 2, 828 North Broadway	Broadway	2-1016
NEW YORK 17, 711 Third Ave.	Murray Hill	7-4133
PHILADELPHIA, Ft. Washington, Pa.	Mitchell	6-5500
PITTSBURGH 34, 300 Mt. Lebanon Blvd.	Locust	1-7808
PORTLAND, Ore.	Capitol	8-1604
RICHMOND, Va.	Milton	4-8379
ST. LOUIS 5, 8000 Bonhomme Ave., Clayton	Parkview	6-0853
SALT LAKE CITY 11, 455 E. 4th South	Davis	8-8861
SAN FRANCISCO 3, 1095 Market St.	Market	1-3464
SEATTLE 9, 1311 Republican St.	Main	3-5505
TULSA 3, 8 E. 4th St.	Gibson	7-3720
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